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MANAGEMENT OF VARIETAL DEGENERATION IN SUGARCANE THROUGH TISSUE CULTURE COMBINED WITH VIRUS TESTING

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Sugarcane production and productivity is severely constrained by diseases caused by fungi, bacteria, viruses and phytoplasmas. The major fungal diseases such as red rot, smut and wilt cause serious damages during disease epidemics and this results in 'varietal replacement'. The non-fungal pathogens like viruses causing yellow leaf disease (YLD) and mosaic and bacterium Leifsonia xyli subsp. xyli causing ratoon stunting disease (RSD) systemically infect sugarcane. Over the years, such systemic accumulation of these pathogens reduces cane and sugar yield. In contrast to fungal diseases, where very severe losses to crop yield are expected in the field, these non-fungal pathogens in sugarcane causes gradual decline in varietal performance. Although these viral/ bacterial pathogens cause limited symptoms in the field, continuous vegetative propagation results in enhanced pathogen titre that would increase the pathogenic potential to cause severe symptoms. Combined infection of two or more viral/bacterial pathogens accelerates the damage to the crop and this is due to infection of one pathogen making the plant more susceptible to another. In this way, a variety degenerates faster and its potential comes down in the field after some years in the field. This phenomenon is referred to as 'varietal degeneration' in sugarcane (Viswanathan and Padmanaban 2008).

The pathogens are not only reducing the yield but also cause the deterioration of the variety due to their accumulation in the stalk over long period of time. Degeneration of popular cv Co 419 in Karnataka state is due its high susceptibility to mosaic, YLD and RSD. Similarly cv CoC 671 another popular variety of tropical region degenerated due its high susceptibility to mosaic and YLD in different parts of Karnataka and Maharashtra. In the past, severe mosaic in sugarcane caused degeneration in popular varieties under cultivation under tropical and subtropical regions (Singh et al., 2003, Viswanathan and Balamuralikrishnan, 2005). Detailed molecular studies established association of Sugarcane mosaic virus and Sugarcane streak mosaic virus (SCSMV) with mosaic either alone or together (Viswanathan et al. 2007). Apart from mosaic, YLD has been found to be serious threat to cane production in different sugarcane growing regions in India. Grassy shoot, a phytoplasma disease also found to associated with low cane productivity in the regions where proper seed nursery programmes is not followed.

After the report of YLD in the country during 1999, systematic studies were conducted on the etiology, epidemiology and management of the disease

(Viswanathan, 2012). The associated pathogen was established as Sugarcane yellow leaf virus (SCYLV). The virus was characterized through molecular tools and occurrence of three virus genotypes was established in the country. Recently assessing impact of the virus infection on physiological parameters viz. photosynthetic rate (A), stomatal conductance (gs) and SPAD meter values revealed significant reduction in sugarcane cultivars. Virus-infected varieties recorded significant reductions in growth/yield parameters, such as stalk height, stalk thickness and number of internodes. Plant growth reductions were found to be 42.9, 42.3 and 38.9% in YLD-susceptible varieties CoPant 84211, Co 86032 and CoC 671, respectively. In addition to reductions in stalk weight, height and girth, YLD also reduced juice yield in the affected canes up to 34.15% (Viswanathan et al. 2014).

Recent studies conducted at the institute have clearly established that viral diseases either alone or in combination cause varietal degeneration in sugarcane and reducing the performance of agronomically superior varieties in the field. This leads to withdrawal of the ruling varieties from cultivation and/or demand for new varieties in different parts of the country. Although cultivation of disease resistant varieties would solve this problem, the newly bred varieties do not possess resistance to viral diseases. Also directed breeding for YLD or mosaic is not being taken up owing to other preferred traits considered for varietal selection. Hence the viral diseases have to be managed only through healthy planting materials. Conventional heat therapy used to eliminate bacterial and phytoplasmal pathogens are ineffective against the viral pathogens.

Tissue culture techniques are suggested to eliminate viruses from systemically infected plants in vegetatively propagated crops. Here also inadvertent virus presence in the seedlings would be catastrophic since this will spread the disease throughout the field. Hence virus diagnosis is always recommended for tissue culture raised plants to ensure their freedom from the viruses. Advancements made in molecular diagnosis were capitalized to standardize diagnostics for sugarcane viruses and phytoplasmas at the institute (Viswanathan, 2012, 2013). The institute also received accreditation for virus indexing of tissue culture raised seedlings in sugarcane from Department of Biotechnology, New Delhi under National Certification System of Tissue Culture raised Plants (NCS-TCP).

The virus indexing has been introduced as a service to sugar industry to produce disease-free seedlings. This venture has helped many sugar industries to revive degenerated varieties during the past five years. During the course we have indexed ~1200 batches of tissue culture samples (in vitro stock cultures) from different tissue culture production units spread over Tamil Nadu, Andhra Pradesh, Maharashtra and Gujarat for the viruses SCYLV, SCMV and SCSMV and grassy shoot phytoplasma by RT-PCR/PCR techniques (Table 1). Close scrutiny of our test reports revealed that the tissue culture production units have improved their skills in producing disease-free planting materials. Under field conditions, disease-free nurseries of the popular variety Co 86032 were developed and varietal degeneration was averted in the regions where clean seed nursery programmes were followed. This approach will

sustain sugarcane productivity in the country by exploiting the yield potential of many popular varieties without degeneration. However, considering the area under sugarcane cultivation, adoption of clean seed nursery programme is far less in the country. To increase overall production of the crop in the country, sugar industry should take up large-scale adoption of healthy seed nursery programmes.

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Table 1: Indexing of mother clones/in vitro stock cultures for virus indexing in sugarcane under NCS-TCP

Year	No of Samples	*Sugarcane yellow leaf virus*		*Sugarcane mosaic virus*		*Sugarcane streak mosaic virus*		Grassy shoot phytoplasma	
		+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve
2009-10	185	179	6	-	-	-	-	33	143
2010-11	378	270	108	13	7	19	1	17	166
2011-12	181	107	74	3	36	3	33	5	111
2012-13	280	257	123	52	208	40	220	34	251
2013-14	180	68	112	33	135	16	152	20	148
Grand Total	1204	881	423	101	387	78	406	109	819

*Note : (-) Not tested; Additionally SCMV and SCSMV were tested for few batches.